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(54) **METHODS AND DEVICES METERING AND COMPACTING EXPLOSIVE POWDERS**

(71) Applicant: **True Velocity IP Holdings, LLC**, Garland, TX (US)

(72) Inventors: **Kenneth J. Overton**, Princeton, TX (US); **Peter Adkins**, Arlington, TX (US); **Tucker Siuts**, Garland, TX (US)

(73) Assignee: **True Velocity IP Holdings, LLC**, Garland, TX (US)

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F42B 33/02	(2006.01)
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CPC ***F42B 33/025*** (2013.01); ***F42B 3/00*** (2013.01); ***F42B 33/001*** (2013.01); ***F42B 33/002*** (2013.01); ***F42B 33/0207*** (2013.01)

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CPC F42B 33/025; F42B 33/001; F42B 33/002; F42B 33/0207
See application file for complete search history.

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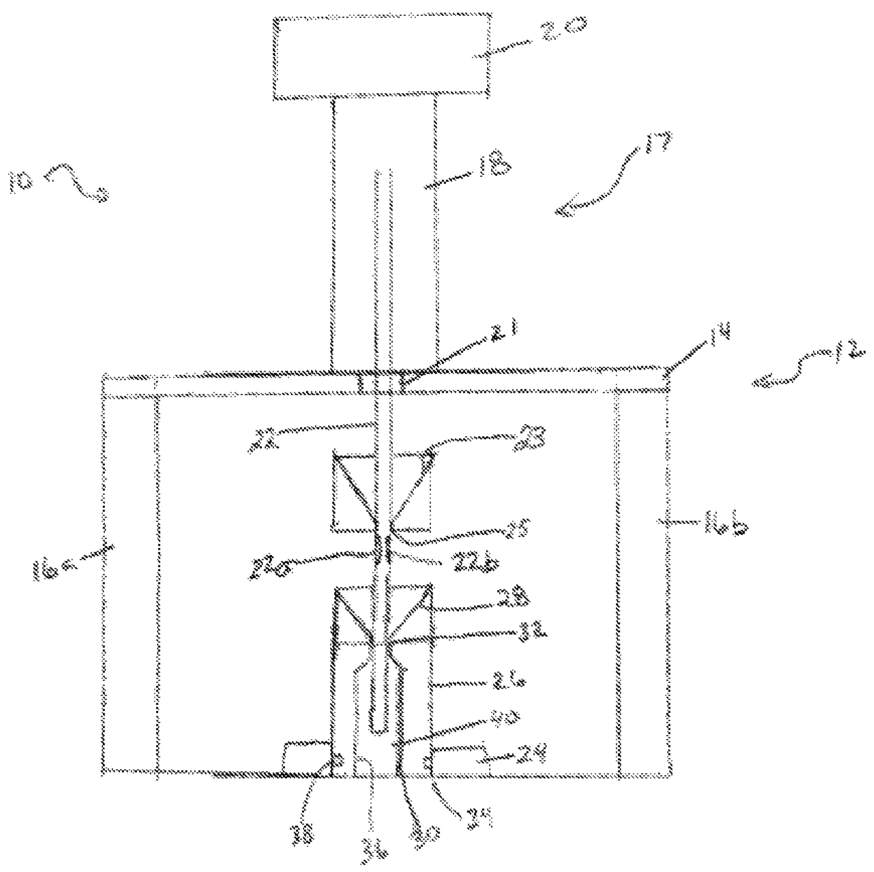
Primary Examiner — Samir Abdosh
(74) *Attorney, Agent, or Firm* — Burdick Patents, P.A.; Sean D. Burdick; Colin L. Honan

(57) **ABSTRACT**

A powder compaction device is disclosed. The device has a drive motor operable connected to a compaction rod that moves through a loading platform to a cartridge holding platform. A powder loading station is positioned below the loading platform and above the cartridge holding platform. The compaction rod moves through the powder loading station, which loads a predetermined volume of propellant powder into one or more reliefs defined in the compaction rod. The cartridge holding platform has a removable cartridge fixture designed to receive an ammunition cartridge to be loaded and compacted with propellant powder. The propellant powder is released into the cartridge fixture from the reliefs as the compaction rod passes a funnel defined at an upper end of the fixture. After releasing the powder, the compaction rod continues into an interior chamber of the fixture to compact the powder contained therein.

20 Claims, 3 Drawing Sheets



Related U.S. Application Data

(60) Provisional application No. 62/820,536, filed on Mar. 19, 2019, provisional application No. 62/820,531, filed on Mar. 19, 2019.

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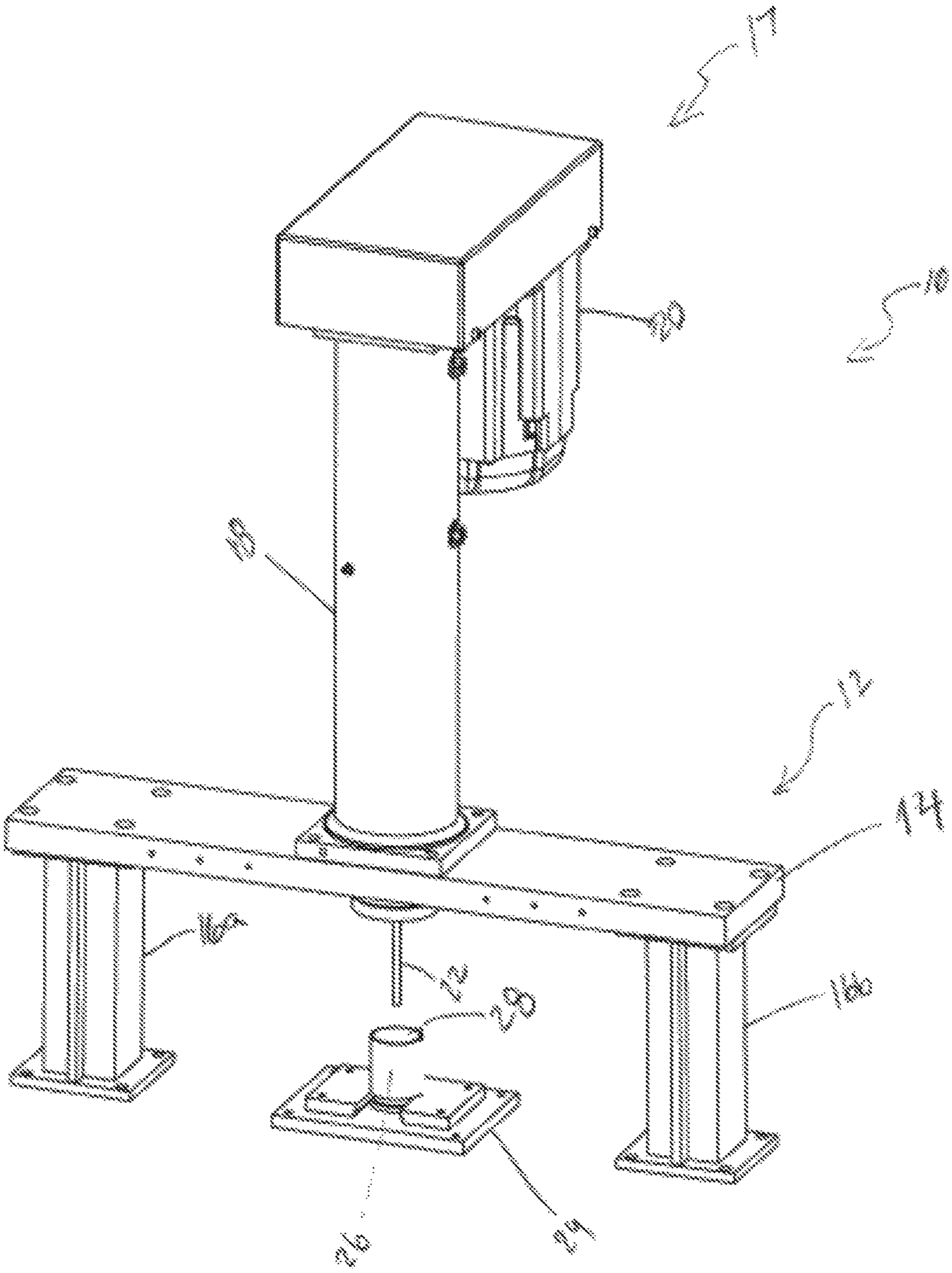

FIGURE 1

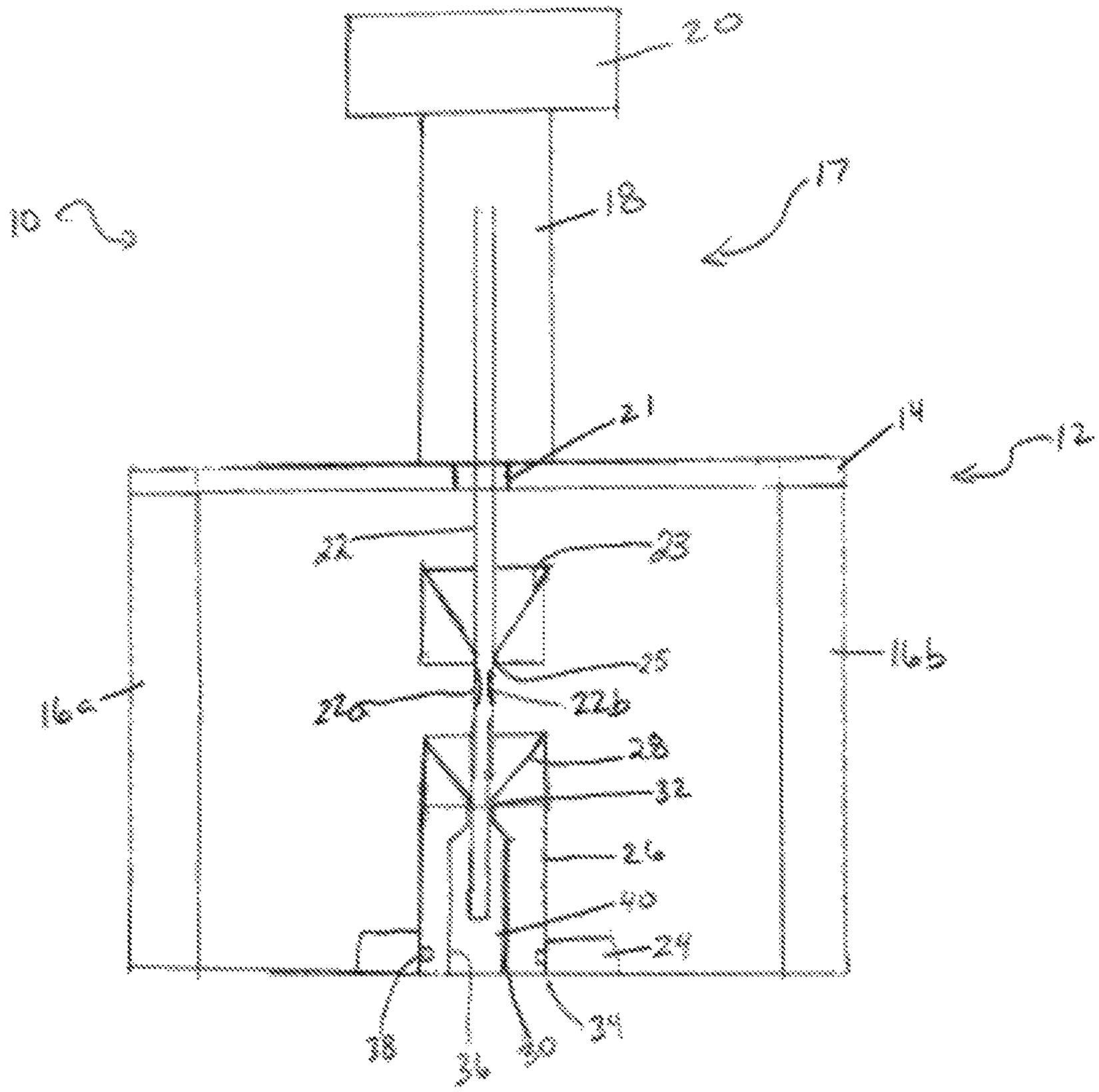

FIGURE 2

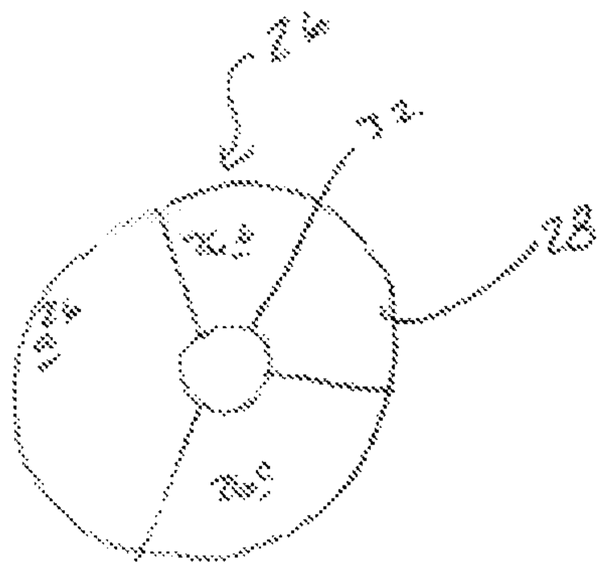

FIGURE 3

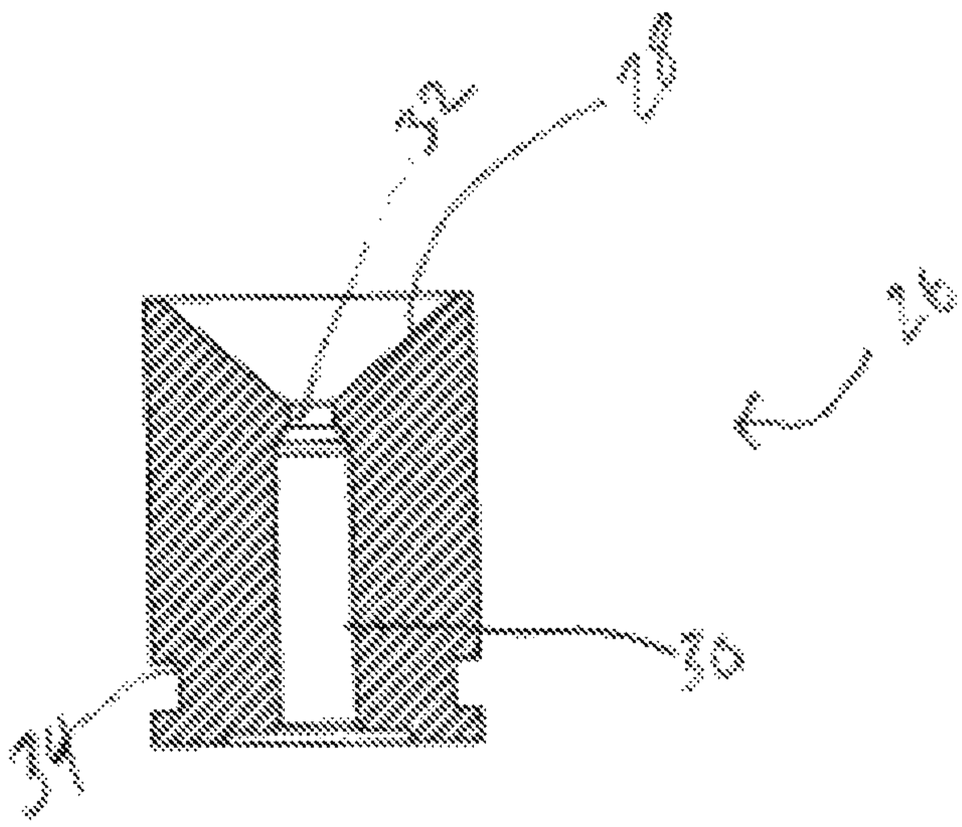

FIGURE 4

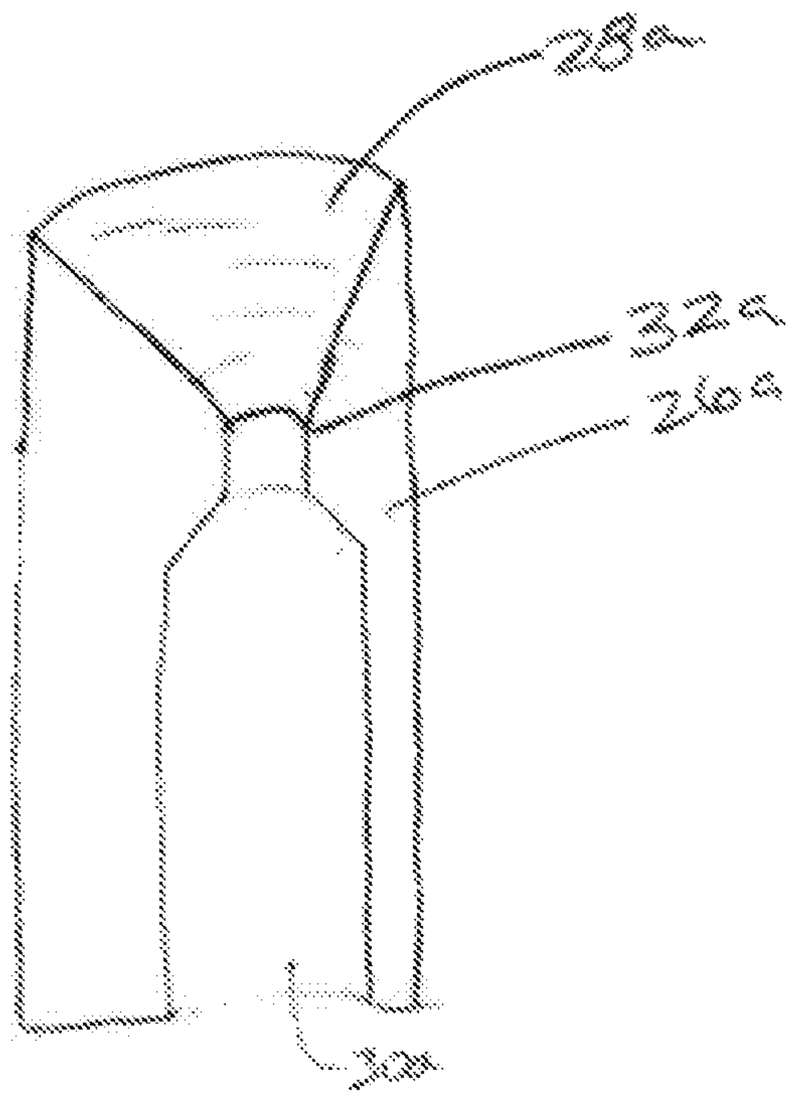

FIGURE 5

METHODS AND DEVICES METERING AND COMPACTING EXPLOSIVE POWDERS

CROSS-REFERENCE TO RELATED APPLICATIONS

This application is a continuation of U.S. application Ser. No. 16/822,313 filed Mar. 18, 2020, which claims priority to U.S. Provisional Application Nos. 62/820,536, and 62/820,531 filed Mar. 19, 2019, all of which are incorporated herein by reference.

TECHNICAL FIELD OF THE INVENTION

The present invention relates in general to the field of forming compacts from powdered material.

STATEMENT OF FEDERALLY FUNDED RESEARCH

None.

INCORPORATION-BY-REFERENCE OF MATERIALS FILED ON COMPACT DISC

None.

BACKGROUND OF THE INVENTION

Without limiting the scope of the invention, its background is described in connection with the compaction of powder in an ammunition cartridge.

U.S. Pat. No. 1,913,259, entitled, "Explosive cartridge and method of making the same," discloses improvements in explosive cartridges and methods of making the same. The invention provides an improved explosive cartridge comprising a powder-packed shell container having its ends closed and sealed cup-shaped closure members which fit nicely into the ends of the container and are interlocked therewith and sealed thereto by means of a self-hardening sealing medium, such as paraffin wax.

U.S. Pat. No. 4,083,912, entitled, "Process for the compression of black powder," discloses a method for the continuous production of compressed higher density black powder comprising feeding from a feed container means mealy black powder of low density enclosed between upper and lower endless belts into a precompression zone, to produce precompressed black powder, and to expel air contained in said black powder, passing the precompressed black powder through a primary compressing zone containing a primary compression means to achieve a new orientation and displacement of the said black powder, then passing the black powder through a final compressing zone containing a final compression means, while supplying the final pressure to obtain breaking or flow of the crystals as well as crystal lattice displacements of said black powder, and recovering the compressed higher density black powder, each of said primary compression means and said final compression means being capable of building-up compaction pressure as well as being capable of idling, the black powder being moved through said precompression zone, said primary compressing zone and said final compressing zone by synchronized lateral movement of said primary and final compression means towards and away from each other and said black powder being withdrawn from said feed container means onto said lower belt by said movement of said primary and final compression means, whereby the build-up of compaction pressure and the idling time of each of said primary and final compression means is synchronized with the forward movement of said black powder caused by the advancing movement of said primary and final compression means.

U.S. Pat. No. 3,670,928, entitled, "Powder metering device for loading ammunition," discloses a powder metering device includes a powder reservoir, a pouring conduit below the reservoir and an elongated cylindrical channel between the reservoir and the pouring conduit. Inlet and outlet openings provide communication into the channel from the reservoir and the pouring conduit, respectively. A cylindrical slide having a reduced diameter portion intermediate its length is slidably mounted in the channel. The reduced diameter portion provides a metering chamber for receiving powder from the inlet conduit and for emptying the powder out of the outlet conduit. The opposite ends of the metering chamber are movable toward and away from one another so as to vary the size of the metering chamber. Grooves on the slide prevent shearing off of powder particles as the slide moves past the inlet opening. Emptying means on the powder reservoir permit the removal of unused powder without the necessity of inverting the metering device.

SUMMARY OF THE INVENTION

The present invention provides a process for the compacting of black powder, which is suitable for a fully or partially automated manufacturing plant.

The present invention provides a powder compaction device comprising a loading platform positioned above a lower platform; a drive motor connected to the loading platform; a compaction rod operably extending from the drive motor through the loading platform, wherein the compaction rod comprises a metering region adjacent to a loading region extending to a compaction end; a first funnel-shaped device positioned below the loading platform, wherein the first funnel-shaped device comprises a first funnel shaped area extending to a first funnel aperture, wherein the first funnel aperture aligns to allow the metering region of the compaction rod to pass through the first funnel aperture; an ammunition cartridge fixture positioned below the first funnel-shaped device, wherein the ammunition cartridge fixture comprises a second funnel-shaped area extending to a second funnel aperture that connects to an ammunition cartridge shaped void adapted to receive an ammunition cartridge, wherein the second funnel aperture aligns with the first funnel aperture to allow the loading region of the compaction rod to pass through the second funnel aperture and the compaction end in the ammunition cartridge shaped void; a one or more metering reliefs positioned in the metering region of the compaction rod, wherein each of the one or more reliefs has a powder metering volume; a powder reservoir comprising a powder housing connected to a powder gate operably connected to a transport conduit in communication with the first funnel-shaped area to transport a powder from the powder housing to the first funnel-shaped area; a compaction controller in communication with the drive motor and one or more first sensors to control the vertical movement of the compaction rod and to control the force applied to the compaction rod end whereby controlling the compaction of the powder at the compaction end; a powder metering controller in communication with the powder gate and one or more second sensors to control the amount of the powder delivered to the first funnel-shaped area; and a loading controller in com-

munication with the drive motor to control the vertical movement of the metering region of the compaction rod, wherein the loading controller positions the metering region and the one or more metering reliefs above the first funnel aperture to allow the powder into the one or more metering reliefs to load the powder, wherein the loading controller releases the powder by moving the metering region and the one or more metering reliefs through the first funnel aperture to allow the powder to release from the one or more metering reliefs and into the second funnel-shaped area of the ammunition cartridge fixture and through the second funnel aperture. In some embodiments the powder compaction device includes the one or more reliefs comprise a first relief and a second relief. In some embodiments the powder compaction device the first relief and a second relief are about equal. In some embodiments the powder compaction device the first relief and a second relief are not equal. In some embodiments the powder compaction device the one or more reliefs comprise 2, 3, 4, 5, 6, 7, 8, 9 10 or more reliefs. In some embodiments the powder compaction device each of the one or more reliefs are about equal. In some embodiments the powder compaction device each of the one or more reliefs are a different. In some embodiments the powder compaction device each of the one or more reliefs increase in volume. In some embodiments the powder compaction device each of the one or more reliefs decrease in volume. In some embodiments the powder compaction device the compaction rod has a diameter of about the diameter of a projectile aperture in the ammunition cartridge. In some embodiments the powder compaction device the ammunition cartridge shaped void is adapted to receive a 223, 0.243, 0.245, 0.25-06, 0.270, 0.277, 6.8 mm, 0.300, 0.308, 0.338, 0.30-30, 0.30-06, 0.45-70 or 0.50-90, 50 caliber, 45 caliber, 380 caliber or 38 caliber, 5.56 mm, 6 mm, 6.5 mm, 7 mm, 7.62 mm, 8 mm, 9 mm, 10 mm, 12.7 mm, 14.5 mm, 14.7 mm, 20 mm, 25 mm, 30 mm, 40 mm, 57 mm, 60 mm, 75 mm, 76 mm, 81 mm, 90 mm, 100 mm, 105 mm, 106 mm, 115 mm, 120 mm, 122 mm, 125 mm, 130 mm, 152 mm, 155 mm, 165 mm, 175 mm, 203 mm or 460 mm, 4.2 inch or 8 inch ammunition cartridge. In some embodiments the powder compaction device further comprises a compaction foot connected to the compaction end of the compaction rod to aid in compaction. In some embodiments the powder compaction device the compaction foot is fixed on the compaction end of the compaction rod. In some embodiments the powder compaction device the compaction foot extendable from the compaction end of the compaction rod. In some embodiments the powder compaction device the compaction foot is offset from the compaction rod. In some embodiments the powder compaction device the compaction foot, the compaction rod or both rotate to compact the powder. In some embodiments the powder compaction device the loading region has a loading region diameter and the metering region has a metering region diameter and the loading region diameter is less than the metering region diameter. In some embodiments the powder compaction device the loading region has a one or more feeding regions that allow passage from the second funnel-shaped area into the ammunition cartridge shaped void.

The present invention provides a method of powder compaction in an ammunition cartridge comprising the steps of: providing a powder compaction device comprising a loading platform positioned above a lower platform; a drive motor connected to the loading platform; a compaction rod operably extending from the drive motor through the loading platform, wherein the compaction rod comprises a metering region adjacent to a loading region extending to a compaction end; a first funnel-shaped device positioned below the loading platform, wherein the first funnel-shaped device comprises a first funnel shaped area extending to a first funnel aperture, wherein the first funnel aperture aligns to allow the metering region of the compaction rod to pass through the first funnel aperture; an ammunition cartridge fixture positioned below the first funnel-shaped device, wherein the ammunition cartridge fixture comprises a second funnel-shaped area extending to a second funnel aperture that connects to an ammunition cartridge shaped void adapted to receive an ammunition cartridge, wherein the second funnel aperture aligns with the first funnel aperture to allow the loading region of the compaction rod to pass through the second funnel aperture and the compaction end in the ammunition cartridge shaped void; a one or more metering reliefs positioned in the metering region of the compaction rod, wherein each of the one or more reliefs has a powder metering volume; a powder reservoir comprising a powder housing connected to a powder gate operably connected to a transport conduit in communication with the first funnel-shaped area to transport a powder from the powder housing to the first funnel-shaped area; a compaction controller in communication with the drive motor and one or more first sensors to control the vertical movement of the compaction rod and to control the force applied to the compaction rod end whereby controlling the compaction of the powder at the compaction end; a powder metering controller in communication with the powder gate and one or more second sensors to control the amount of the powder delivered to the first funnel-shaped area; and a loading controller in communication with the drive motor to control the vertical movement of the metering region of the compaction rod, wherein the loading controller positions the metering region and the one or more metering reliefs above the first funnel aperture to allow the powder into the one or more metering reliefs to load the powder, wherein the loading controller releases the powder by moving the metering region and the one or more metering reliefs through the first funnel aperture to allow the powder to release from the one or more metering reliefs and into the second funnel-shaped area of the ammunition cartridge fixture and through the second funnel aperture; positioning an ammunition cartridge in the ammunition cartridge shaped void; moving the metering region into the first funnel shaped area above the first funnel aperture; releasing a first powder load into the first funnel shaped area; filling the one or more reliefs with the powder; moving the metering region through the first funnel aperture to release the powder from the one or more reliefs into the second funnel-shaped area; allowing the powder to pass through the second funnel aperture into the ammunition cartridge; moving the compaction end into the ammunition cartridge to compress the powder; compressing the powder with the compaction end; removing the compaction end from the ammunition cartridge and the second funnel aperture; and removing the ammunition cartridge in the ammunition cartridge shaped void. In some embodiments, the method of powder compaction in an ammunition cartridge further comprises the steps of additional powder compactions by repeating powder compaction steps one or more times, wherein the powder compactions steps comprise moving the metering region into the first funnel shaped area above the first funnel aperture; releasing a first powder load into the first funnel shaped area; filling the one or more reliefs with the powder; moving the metering region through the first funnel aperture to release the powder from the one or more reliefs into the second funnel-shaped area; allowing the powder to pass through the second funnel aperture into

the ammunition cartridge; moving the compaction end into the ammunition cartridge to compress the powder; compressing the powder with the compaction end; removing the compaction end from the ammunition cartridge and the second funnel aperture before removing the ammunition cartridge in the ammunition cartridge shaped void. In some embodiments, the method of powder compaction in an ammunition cartridge further comprises a compaction foot connected to the compaction end of the compaction rod to aid in compaction. In some embodiments, the method of powder compaction in an ammunition cartridge includes the compaction foot is fixed on the compaction end of the compaction rod. In some embodiments, the method of powder compaction in an ammunition cartridge includes the compaction foot extendable from the compaction end of the compaction rod and further comprising the step of rotating the compaction rod to rotate the compaction foot. In some embodiments, the method of powder compaction in an ammunition cartridge includes the compaction foot is offset from the compaction rod and further comprising the step of rotating the compaction rod to rotate the compaction foot. In some embodiments, the method of powder compaction in an ammunition cartridge includes the one or more reliefs comprise a first relief and a second relief. In some embodiments, the method of powder compaction in an ammunition cartridge includes the first relief and a second relief are about equal. In some embodiments, the method of powder compaction in an ammunition cartridge includes the first relief and a second relief are not equal. In some embodiments, the method of powder compaction in an ammunition cartridge includes the one or more reliefs comprise 2, 3, 4, 5, 6, 7, 8, 9 10 or more reliefs. In some embodiments, the method of powder compaction in an ammunition cartridge includes each of the one or more reliefs are about equal. In some embodiments, the method of powder compaction in an ammunition cartridge includes each of the one or more reliefs are a different. In some embodiments, the method of powder compaction in an ammunition cartridge includes each of the one or more reliefs increase in volume. In some embodiments, the method of powder compaction in an ammunition cartridge includes each of the one or more reliefs decrease in volume. In some embodiments, the method of powder compaction in an ammunition cartridge includes the compaction rod has a diameter of about the diameter of a projectile aperture in the ammunition cartridge. In some embodiments, the method of powder compaction in an ammunition cartridge includes the ammunition cartridge shaped void is adapted to receive a 223, 0.243, 0.245, 0.25-06, 0.270, 0.277, 6.8 mm, 0.300, 0.308, 0.338, 0.30-30, 0.30-06, 0.45-70 or 0.50-90, 50 caliber, 45 caliber, 380 caliber or 38 caliber, 5.56 mm, 6 mm, 6.5 mm, 7 mm, 7.62 mm, 8 mm, 9 mm, 10 mm, 12.7 mm, 14.5 mm, 14.7 mm, 20 mm, 25 mm, 30 mm, 40 mm, 57 mm, 60 mm, 75 mm, 76 mm, 81 mm, 90 mm, 100 mm, 105 mm, 106 mm, 115 mm, 120 mm, 122 mm, 125 mm, 130 mm, 152 mm, 155 mm, 165 mm, 175 mm, 203 mm or 460 mm, 4.2 inch or 8 inch ammunition cartridge.

BRIEF DESCRIPTION OF THE DRAWINGS

For a more complete understanding of the features and advantages of the present invention, reference is now made to the detailed description of the invention along with the accompanying figures and in which:

FIG. **1** is a prospective view that depicts one embodiment of the powder loading, metering and compaction device of the present invention;

FIG. **2** depicts a cut through image of one embodiment of the powder loading metering and compaction device of the present invention;

FIG. **3** is a top down view of one embodiment of the ammunition cartridge fixture of the present invention;

FIG. **4** is a cut through image of one embodiment of the ammunition cartridge fixture of the present invention; and

FIG. **5** is a cut through image of one embodiment of a segment of the ammunition cartridge fixture of the present invention.

DETAILED DESCRIPTION OF THE INVENTION

While the making and using of various embodiments of the present invention are discussed in detail below, it should be appreciated that the present invention provides many applicable inventive concepts that can be embodied in a wide variety of specific contexts. The specific embodiments discussed herein are merely illustrative of specific ways to make and use the invention and do not delimit the scope of the invention.

To facilitate the understanding of this invention, a number of terms are defined below. Terms defined herein have meanings as commonly understood by a person of ordinary skill in the areas relevant to the present invention. Terms such as "a", "an" and "the" are not intended to refer to only a singular entity, but include the general class of which a specific example may be used for illustration. The terminology herein is used to describe specific embodiments of the invention, but their usage does not delimit the invention, except as outlined in the claims.

In operation, The present invention provides a powder compaction device comprising a loading platform positioned above a lower platform; a drive motor connected to the loading platform; a compaction rod operably extending from the drive motor through the loading platform, wherein the compaction rod comprises a metering region adjacent to a loading region extending to a compaction end; a first funnel-shaped device positioned below the loading platform, wherein the first funnel-shaped device comprises a first funnel shaped area extending to a first funnel aperture, wherein the first funnel aperture aligns to allow the metering region of the compaction rod to pass through the first funnel aperture; an ammunition cartridge fixture positioned below the first funnel-shaped device, wherein the ammunition cartridge fixture comprises a second funnel-shaped area extending to a second funnel aperture that connects to an ammunition cartridge shaped void adapted to receive an ammunition cartridge, wherein the second funnel aperture aligns with the first funnel aperture to allow the loading region of the compaction rod to pass through the second funnel aperture and the compaction end in the ammunition cartridge shaped void; a one or more metering reliefs positioned in the metering region of the compaction rod, wherein each of the one or more reliefs has a powder metering volume; a powder reservoir comprising a powder housing connected to a powder gate operably connected to a transport conduit in communication with the first funnel-shaped area to transport a powder from the powder housing to the first funnel-shaped area; a compaction controller in communication with the drive motor and one or more first sensors to control the vertical movement of the compaction rod and to control the force applied to the compaction rod end whereby controlling the compaction of the powder at the compaction end; a powder metering controller in communication with the powder gate and one or more second

sensors to control the amount of the powder delivered to the first funnel-shaped area; and a loading controller in communication with the drive motor to control the vertical movement of the metering region of the compaction rod, wherein the loading controller positions the metering region and the one or more metering reliefs above the first funnel aperture to allow the powder into the one or more metering reliefs to load the powder, wherein the loading controller releases the powder by moving the metering region and the one or more metering reliefs through the first funnel aperture to allow the powder to release from the one or more metering reliefs and into the second funnel-shaped area of the ammunition cartridge fixture and through the second funnel aperture.

The present invention provides a method of powder compaction in an ammunition cartridge comprising the steps of: providing a powder compaction device comprising a loading platform positioned above a lower platform; a drive motor connected to the loading platform; a compaction rod operably extending from the drive motor through the loading platform, wherein the compaction rod comprises a metering region adjacent to a loading region extending to a compaction end; a first funnel-shaped device positioned below the loading platform, wherein the first funnel-shaped device comprises a first funnel shaped area extending to a first funnel aperture, wherein the first funnel aperture aligns to allow the metering region of the compaction rod to pass through the first funnel aperture; an ammunition cartridge fixture positioned below the first funnel-shaped device, wherein the ammunition cartridge fixture comprises a second funnel-shaped area extending to a second funnel aperture that connects to an ammunition cartridge shaped void adapted to receive an ammunition cartridge, wherein the second funnel aperture aligns with the first funnel aperture to allow the loading region of the compaction rod to pass through the second funnel aperture and the compaction end in the ammunition cartridge shaped void; a one or more metering reliefs positioned in the metering region of the compaction rod, wherein each of the one or more reliefs has a powder metering volume; a powder reservoir comprising a powder housing connected to a powder gate operably connected to a transport conduit in communication with the first funnel-shaped area to transport a powder from the powder housing to the first funnel-shaped area; a compaction controller in communication with the drive motor and one or more first sensors to control the vertical movement of the compaction rod and to control the force applied to the compaction rod end whereby controlling the compaction of the powder at the compaction end; a powder metering controller in communication with the powder gate and one or more second sensors to control the amount of the powder delivered to the first funnel-shaped area; and a loading controller in communication with the drive motor to control the vertical movement of the metering region of the compaction rod, wherein the loading controller positions the metering region and the one or more metering reliefs above the first funnel aperture to allow the powder into the one or more metering reliefs to load the powder, wherein the loading controller releases the powder by moving the metering region and the one or more metering reliefs through the first funnel aperture to allow the powder to release from the one or more metering reliefs and into the second funnel-shaped area of the ammunition cartridge fixture and through the second funnel aperture; positioning an ammunition cartridge in the ammunition cartridge shaped void; moving the metering region into the first funnel shaped area above the first funnel aperture; releasing a first powder load into the first funnel shaped area; filling the one or more reliefs with the powder; moving the metering region through the first funnel aperture to release the powder from the one or more reliefs into the second funnel-shaped area; allowing the powder to pass through the second funnel aperture into the ammunition cartridge; moving the compaction end into the ammunition cartridge to compress the powder; compressing the powder with the compaction end; removing the compaction end from the ammunition cartridge and the second funnel aperture; and removing the ammunition cartridge in the ammunition cartridge shaped void.

FIG. **1** is a prospective view that depicts one embodiment of the powder loading, metering and compaction device of the present invention. The compaction device **10** includes a frame **12** which may be constructed of polymer, plastic, metal or any other desirable rigid material. The frame **12** includes a platform **14** that is supported by one or more risers **16***a* and **16***b*. The one or more risers **16***a* and **16***b* may be constructed of polymer, plastic, metal or any other desirable rigid material and may be of any height necessary for the operation of the compaction device **10**. A drive device **17** is connected to the platform **14**. The drive device **17** include a vertical tube **18** housing a movable compaction rod **22**. The vertical tube **18** extending from the platform **14** to a drive motor **20** to move the compaction rod **22**. Although the drive motor **20** is depicted at the top of the vertical tube **18** it may be positioned at any location allowing activation of the compaction rod **22** with the desired degree of movement. The drive motor **20** may be a pneumatic or electric motor that is gear, belt, chain or directly driven to actuate the compaction rod **22**. The platform **14** includes a compaction rod aperture (not shown) position in communication the vertical tube **18** to allow passage of the compaction rod **22** through the platform **14**. The compaction rod **22** extends through the compaction rod aperture (not shown) and is positioned in the vertical tube **18** in operable communication with the drive motor **20** which moves the compaction rod **22** toward and away from the platform **14**. A holding platform **24** is aligned with and in communication with the compaction rod aperture (not shown). The holding platform **24** slidably accepts an ammunition cartridge fixture **26**. The ammunition cartridge fixture **26** is slidably secured in the adaptor platform **24** to align the compaction rod aperture (not shown) and the compaction rod **22** with the ammunition cartridge fixture **26**. The ammunition cartridge fixture **26** includes a funnel-shaped opening **28** with a funnel aperture (not shown) connected to an interior chamber (not shown) within the ammunition cartridge fixture **26**. The funnel aperture (not shown) and compaction rod aperture (not shown) are aligned to allow the compaction rod **22** enter the interior chamber (not shown) of the ammunition cartridge fixture **26**.

The drive motor **20** may be manually controlled or automatically controlled. The drive motor **20** includes one or more sensors to measure, record, transmit, store, or report one or more physical measurements. For example, the one or more sensors may be force and/or distance sensor that measure the force applied to the compaction rod, the force exerted by the motor, the compression force applied at the tip of the compaction rod, the distance the compaction rod moves, etc. The data from the sensors may be stored, reported and/or used to control the operation of the drive motor. For example, the sensor may record the force applied to the powder and when a specific compression force (e.g., 5-5000 psi) is reached the motor will reverse direction to move the compaction rod opposite direction. The specific

parameters (distance or force curve) may vary and depend on the specific powders, caliber, compaction rod diameter or tip profile being used.

FIG. **2** is a prospective view that depicts one embodiment of the powder loading, metering and compaction device of the present invention. The compaction device **10** includes a frame **12** which may be constructed of polymer, plastic, metal or any other desirable rigid material. The frame **12** includes a platform **14** that is supported by one or more risers **16***a* and **16***b*. The one or more risers **16***a* and **16***b* may be constructed of polymer, plastic, metal or any other desirable rigid material and may be of any height necessary for the operation of the compaction device **10**. A drive device **17** is connected to the platform **14**. The drive device **17** include a vertical tube **18** housing, a drive motor **20** and a movable compaction rod **22**. The vertical tube **18** extends from the platform **14** to the drive motor **20** to move the compaction rod **22**. Although the drive motor **20** is depicted at the top of the vertical tube **18** it may be positioned at any location allowing activation and movement of the compaction rod **22** to the desired degree of movement. The drive motor **20** may be a pneumatic or electric motor that is gear, belt chain or directly driven to actuate the compaction rod **22**. The platform **14** includes a compaction rod aperture **21** position in communication the vertical tube **18** to allow passage of the compaction rod **22** through the platform **14**. The compaction rod **22** extends through the compaction rod aperture **21** and is positioned in the vertical tube **18** in operable communication with the drive motor **20** which moves the compaction rod **22** toward and away from the platform **14**. A first funnel-shaped device **23** for housing powder is positioned below the platform **14**. A first funnel aperture **25** is positioned in the first funnel-shaped device **23** and aligned with the compaction rod aperture **21** to allow the compaction rod **22** to pass through the compaction rod aperture **21** and through the first funnel aperture **25**. A holding platform **24** is aligned with and in communication with the compaction rod aperture **21** and the first funnel aperture **25**. The holding platform **24** accepts an ammunition cartridge fixture **26**. The ammunition cartridge fixture **26** includes a funnel-shaped opening **28** with a funnel aperture **32** extending into an interior chamber **30**. The funnel aperture **32** aligns with the first funnel aperture **25** and the compaction rod aperture **21** to accommodate the movement of the compaction rod **22** into the interior chamber **30**. The ammunition cartridge fixture **26** may be constructed of polymer, plastic, metal or any other desirable rigid material. The interior chamber **30** of the ammunition cartridge fixture **26** has the profile of the ammunition cartridge being loaded such that the interior chamber **30** mimics the shape of an ammunition cartridge chamber. The ammunition cartridge fixture **26** supports the ammunition cartridge on all sides as it is supported in a chamber of the corresponding rifle. The ammunition cartridge being loaded may be any ammunition cartridge caliber. For example, loading a 7.62 mm ammunition cartridge requires an interior chamber **30** with a profile that mates to the 7.62 mm ammunition cartridge.

The ammunition cartridge fixture **26** is aligned and positioned below the first funnel-shaped device **23**. The ammunition cartridge fixture **26** includes a funnel-shaped opening **28** positioned adjacently above and in communication with the interior chamber **30** through the funnel aperture **32**. The funnel-shaped opening **28** allows propellant to be funneled into the ammunition cartridge (not shown) placed into the ammunition cartridge fixture **26**. The ammunition cartridge fixture **26** includes a lower groove **34** that is adapted to slide into the tongue **38** of the adaptor platform **24** to secure the ammunition cartridge fixture **26** in position. In one embodiment, the ammunition cartridge fixture **26** is slidably secured in the adaptor platform **24** to align the compaction rod aperture **21**, the first funnel aperture **25** and the funnel aperture **32** to allow movement of the compaction rod **22** into the interior chamber **30**. In another embodiment, the ammunition cartridge fixture **26** is comprised of 2, 3, 4, or more sections that are moved together to form the ammunition cartridge fixture **26**.

The compaction rod **22** includes reliefs **22***a* and **22***b* located in the wall of the compaction rod **22**. The reliefs **22***a* and **22***b* are positioned to correspond to the position of the first funnel aperture **25** to act as a metering device. Initially the reliefs **22***a* and **22***b* are positioned in the first funnel-shaped device **23** above the first funnel aperture **25**. Powder added to the first funnel-shaped device **23** fills the reliefs **22***a* and **22***b*. As compaction rod **22** is moved by the drive motor **20** the reliefs **22***a* and **22***b* move through the first funnel aperture **25** to locate the reliefs **22***a* and **22***b* below the first funnel aperture **25**. As the reliefs **22***a* and **22***b* upon passing through the first funnel aperture **25** the powder is released. The released powder is transferred to the funnel-shaped opening **28**. The size, shape, number, location, depth, etc. of the reliefs **22***a* and **22***b* may be varied to finetune the amount of powder released. The powder is then transferred into the interior chamber **30**. The compaction rod **22** is moved by the drive motor **20** through the funnel aperture **32** and into the interior chamber **30** for compaction. The compaction rod **22** may have a compaction rod tip at the compaction end that is flat, convex, concave, curved, angled or any other shape. In addition, the compaction rod **22** may be hollow to allow passage through the compaction rod **22**. The compaction rod **22** may be removable and replicable either entirely or partially. The compaction rod **22** may be adapted to receive a replaceable compaction rod tip depending on the particular application.

The drive motor **20** may be manually controlled or automatically controlled. The drive motor **20** includes one or more sensors to measure, record, transmit, store, or report one or more physical measurements. For example, the one or more sensors may be force and/or distance sensor that measure the force applied to the compaction rod, the force exerted by the motor, the compression force applied at the tip of the compaction rod, the distance the compaction rod moves, etc. The data from the sensors may be stored, reported and/or used to control the operation of the drive motor. For example, the sensor may record the force applied to the powder and when a specific compression force (e.g., 5-5000 psi) is reached the motor will reverse direction to move the compaction rod opposite direction. The specific parameters (distance or force curve) may vary and depend on the specific powders, caliber, compaction rod diameter or tip profile being used.

In operation an ammunition cartridge **36** to be loaded with powder is positioned in the ammunition cartridge fixture **26** such that the ammunition cartridge **36** mates to the interior chamber **30**. The ammunition cartridge fixture **26** is positioned in the adaptor platform **24** by sliding the lower groove **34** of the ammunition cartridge fixture **26** into the tongue **38** of the adaptor platform **24**. The ammunition cartridge fixture **26** is secured in the adaptor platform **24** allowing the ammunition cartridge interior **40** to be accessible through the funnel-shaped opening **28**. Powder is placed in the first funnel-shaped device **23** and the compaction rod **22** extends into the funnel-shaped opening **28** and through the first funnel aperture **25**. The reliefs **22***a* and **22***b* of the compaction rod **22** are positioned in the first funnel-shaped device

23 and filled with the powder. The drive motor **20** moves the compaction rod **22** to transition the reliefs **22***a* and **22***b* and powder contained therein through the first funnel aperture **25**. As the reliefs **22***a* and **22***b* exit the first funnel aperture **25** the powder contained in the reliefs **22***a* and **22***b* is released. The controlled volume and release of the powder serves to meters the amount of powder delivered for compaction. The powder is then transported into the funnel-shaped opening **28** which is then funneled through the funnel aperture **32** and into the ammunition cartridge **36**. The compaction rod **22** is moved through the funnel aperture **32** and into the ammunition cartridge interior **40** to contact the deposited powder for compaction. The drive motor **20** is activated to move the compaction rod **22** contacts the powder and moved to compress the powder to a specific preset distance of movement or pressure. Once the powder is compressed the compaction rod **22** may be removed (either manually or automatically), the ammunition cartridge fixture **26** is removed from the adaptor platform **24** and the ammunition cartridge **36** removed from the interior chamber **30**. During operation the powder may be added in stages and then compressed at each stage to form a layered powder configuration. Alternatively, the powder may be added in single stage or layer and then compressed. Each stage or layer may use the same powder or a different powder. Similarly, each stage or layer may be compressed to a different degree of compaction. As a result, the individual cartridge powder compaction may be fine-tuned through the adjustment of the type of powder, the number of powders, the distribution (or layers) of the powders, the amount of compression, the compaction of the layers of the powders, etc.

FIG. **3** is a top down view of one embodiment of the ammunition cartridge fixture of the present invention. The ammunition cartridge fixture **26** which may be constructed of polymer, plastic, metal or any other desirable rigid material. The ammunition cartridge fixture **26** includes a funnel-shaped opening **28** with a funnel aperture **32** that passes into an interior chamber (not shown). The ammunition cartridge fixture **26** is seen as a multipart fixture having body portions **26***a*, **26***b* and **26***c* that mate to complete the funnel-shaped opening **28** with a funnel aperture **32** that passes into an interior chamber (not shown).

FIG. **4** is a cut through image of one embodiment of the ammunition cartridge fixture of the present invention. The ammunition cartridge fixture **26** which may be constructed of polymer, plastic, metal or any other desirable rigid material. The ammunition cartridge fixture **26** includes an interior chamber **30** which has the profile of the ammunition cartridge being loaded. The interior chamber **30** mimics the shape of an ammunition cartridge chamber and supports the ammunition cartridge on all sides as in the chamber of the corresponding rifle. The ammunition cartridge being loaded may be any ammunition cartridge caliber. For example, loading a 7.62 mm ammunition cartridge requires an interior chamber **30** with a profile that mates to the 7.62 mm ammunition cartridge. The ammunition cartridge fixture **26** includes a funnel-shaped opening **28** positioned adjacently above and in communication with the interior chamber **30** through the funnel aperture **32**. The funnel-shaped opening **28** allows powder to be funneled into the ammunition cartridge (not shown) secured in the interior chamber **30** of the ammunition cartridge fixture **26**. The ammunition cartridge fixture **26** includes a lower groove **34** that is adapted to slide into the adaptor platform (not shown) to secure the ammunition cartridge fixture **26** in position.

FIG. **5** is a cut through image of one embodiment of a segment of the ammunition cartridge fixture of the present invention. The ammunition cartridge fixture segment **26***a* is a portion of the ammunition cartridge fixture (not shown) that when combined makes up the completed ammunition cartridge fixture (not shown). The ammunition cartridge fixture segment **26***a* includes a funnel-shaped opening **28***a* the funnels to a funnel aperture segment **32***a* that is in communication with the interior chamber segment **30***a* which has the profile of a portion of the ammunition cartridge being loaded. The interior chamber segment **30***a* mimics the shape of an ammunition cartridge chamber. Each of the ammunition cartridge fixture segment **26***a* supports a portion of the ammunition cartridge (not shown) on the side wall (not shown), the neck (not shown) and the nose (not shown) as the ammunition cartridge is supported in the chamber of the corresponding rifle. In the depicted embodiment the completed ammunition cartridge fixture (not shown) is made up of 3 ammunition cartridge fixture segments. However, the ammunition cartridge fixture (not shown) may be made of 2, 3, 4, or more ammunition cartridge fixture segment that are moved together to form the ammunition cartridge fixture **26**. Similarly, the funnel-shaped opening may be a single member that is in communication with a multipiece ammunition cartridge fixture having 2, 3, 4, or more ammunition cartridge fixture segment that are moved together to form the interior chamber (not shown). The ammunition cartridge fixture segments when mated supports the ammunition cartridge on all sides as in a chamber of the corresponding rifle. The ammunition cartridge being loaded may be any ammunition cartridge caliber. For example, loading a 7.62 mm ammunition cartridge requires an interior chamber **30** with a profile that mates to the 7.62 mm ammunition cartridge.

The powder may be any powder or propellant know to the skilled artisan for use in ammunition loading. For example, vihta vuori n310, alliant blue dot, hodgdon varget, accurate arms nitro 100, accurate arms no. 7, imr 4320, alliant e3, alliant pro reach, winchester 748, hodgdon titewad, hodgdon longshot, hodgdon bl-c(2), ramshot competition, alliant 410, hodgdon cfe 223, alliant red dot, alliant 2400, hodgdon leverevolution, alliant promo, ramshot enforcer, hodgdon h380, hodgdon clays, accurate arms no.9, ramshot big game, imr red, accurate arms 4100, vihtavuori n540, alliant clay dot, alliant steel, winchester 760, hodgdon hi-skor 700-x, norma 8123, hodgdon h414, alliant bullseye, vihtavuori n110, vihtavuori n150, imr target, hodgdon lil' gun, accurate arms 2700, hodgdon titegroup, hodgdon 110, imr 4350, alliant american select, winchester 296, imr 4451, accurate arms solo 1000, imr 4227, hodgdon h4350, alliant green dot, accurate arms 5744, alliant reloder 17, imr green, accurate arms 1680, accurate arms 4350, winchester wst, hodgdon cfe blk, norma 204, hodgdon trail boss, norma 200, hodgdon hybrid 100v, winchester super handicap, alliant reloder 7, vihtavuori n550, hodgdon international, imr 4198, alliant-reloder 19, accurate arms solo 1250, hodgdon h4198, imr 4831, vihtavuori n320, vihta vuori n120, ramshot hunter, accurate arms no. 2, hodgdon h322, accurate arms 3100, ramshot zip, accurate arms 2015br, vihtavuori n160, hodgdon hp-38, alliant reloder 10×, hodgdon h4831 & h4831sc, winchester 231, vihta vouri n130, hodgdon superformance, alliant 20/28, imr 3031, imr 4955, winchester 244, vihtavouri n133, winchester supreme 780, alliant unique, hodgdon benchmark, norma mrp, hodgdon universal, hodgdon h335, alliant reloder 22, imr unequal, ramshot x-terminator, vihtavuori n560, alliant power pistol, accurate arms 2230, vihtavuori n165, vihta vuori n330, accurate arms

2460s, imr 7828 & imr 7828 ssc, alliant herco, imr 8208 xbr, alliant reloder 25, winchester wsf, ramshot tac, vihtavuori n170, vihtavuori n340, hodgdon h4895, accurate arms magpro, hodgdon hi-skor 800-x, vihtavuori n530 140 imr 7977, ramshot true blue, imr 4895, hodgdon h1000, accurate arms no. 5, vihtavuori n135, ramshot magnum, hodgdon hs-6, alliant reloder 12, hodgdon retumbo, winchester auto-comp, accurate arms 24951r, imr 8133, hodgdon cfe pistol, imr 4166, vihtavuori n570, ramshot silhouette, imr 4064, accurate arms 8700, vihtavuori 3n37, norma 202, vihta vuori 24n41, vihtavuori n350, accurate arms 4064, hodgdon 50 bmg, vihtavuori 3n318, accurate arms 2520, hodgdon us869, imr blue, alliant reloder 15, vihtavuori 20n29, or other similar powders or propellants.

The present invention is not limited to the described caliber and is believed to be applicable to other calibers as well. This includes various small, medium and large caliber munitions, including 5.56 mm, 7.62 mm, 308, 338, 3030, 3006, and .50 caliber ammunition cartridges, as well as medium/small caliber ammunition such as 380 caliber, 38 caliber, 9 mm, 10 mm, 20 mm, 25 mm, 30 mm, 40 mm, 45 caliber and the like. The projectile and the corresponding cartridge may be of any desired size, e.g., 0.223, 0.243, 0.245, 0.25-06, 0.270, 0.277, 6.8 mm, 0.300, 0.308, 0.338, 0.30-30, 0.30-06, 0.45-70 or 0.50-90, 50 caliber, 45 caliber, 380 caliber or 38 caliber, 5.56 mm, 6 mm, 6.5 mm, 7 mm, 7.62 mm, 8 mm, 9 mm, 10 mm, 12.7 mm, 14.5 mm, 14.7 mm, 20 mm, 25 mm, 30 mm, 40 mm, 57 mm, 60 mm, 75 mm, 76 mm, 81 mm, 90 mm, 100 mm, 105 mm, 106 mm, 115 mm, 120 mm, 122 mm, 125 mm, 130 mm, 152 mm, 155 mm, 165 mm, 175 mm, 203 mm or 460 mm, 4.2 inch or 8 inch. The cartridges, therefore, are of a caliber between about .05 and about 5 inches. Thus, the present invention is also applicable to the sporting goods industry for use by hunters and target shooters.

The present invention includes a motor controller in communication with at least the drive motor and/or one or more sensors. The motor controller may also include one or more microprocessors, a servo amplifier for driving the motor and a proportional integral derivative (PID) filter for controlling the motor based upon feedback from the motor and/or the one or more sensors. The motor controller may also be connected to a computer or memory module that contain information regarding parameters of the motion of the drive motor to control the force, actual position, velocity, errors and/or motor status. The position, force, velocity or acceleration of the compaction rod or the drive motor can be programmed into the controller with extreme precision in any of those parameters, yielding extremely fine resolution and control over the drive motor. The controller has a communications port that may be accessed by an RS232 plug from a personal computer. Two or more controllers can be linked together via their communication ports to provide multi-axis motion with the controllers and their connected motors synchronized. A peripheral device port located adjacent to the communications port on a back end of the controller affords connections for devices such as a flat panel display, which may be mounted on the controller and display information regarding the motor or controller, or joystick for controlling the motor directly.

In addition, the present invention may include a powder reservoir in communication with the funnel-shaped opening directly or through a pouring conduit below the reservoir and extending to the funnel-shaped opening either with or without a gate or slide to control flow.

It will be understood that particular embodiments described herein are shown by way of illustration and not as limitations of the invention. The principal features of this invention can be employed in various embodiments without departing from the scope of the invention. Those skilled in the art will recognize, or be able to ascertain using no more than routine experimentation, numerous equivalents to the specific procedures described herein. Such equivalents are considered to be within the scope of this invention and are covered by the claims.

All publications and patent applications mentioned in the specification are indicative of the level of skill of those skilled in the art to which this invention pertains. All publications and patent applications are herein incorporated by reference to the same extent as if each individual publication or patent application was specifically and individually indicated to be incorporated by reference.

The use of the word "a" or "an" when used in conjunction with the term "comprising" in the claims and/or the specification may mean "one," but it is also consistent with the meaning of "one or more," "at least one," and "one or more than one." The use of the term "or" in the claims is used to mean "and/or" unless explicitly indicated to refer to alternatives only or the alternatives are mutually exclusive, although the disclosure supports a definition that refers to only alternatives and "and/or." Throughout this application, the term "about" is used to indicate that a value includes the inherent variation of error for the device, the method being employed to determine the value, or the variation that exists among the study subjects.

As used in this specification and claim(s), the words "comprising" (and any form of comprising, such as "comprise" and "comprises"), "having" (and any form of having, such as "have" and "has"), "including" (and any form of including, such as "includes" and "include") or "containing" (and any form of containing, such as "contains" and "contain") are inclusive or open-ended and do not exclude additional, unrecited elements or method steps.

The term "or combinations thereof" as used herein refers to all permutations and combinations of the listed items preceding the term. For example, "A, B, C, or combinations thereof" is intended to include at least one of: A, B, C, AB, AC, BC, or ABC, and if order is important in a particular context, also BA, CA, CB, CBA, BCA, ACB, BAC, or CAB. Continuing with this example, expressly included are combinations that contain repeats of one or more item or term, such as BB, AAA, MB, BBC, AAABCCCC, CBBAAA, CABABB, and so forth. The skilled artisan will understand that typically there is no limit on the number of items or terms in any combination, unless otherwise apparent from the context.

All of the compositions and/or methods disclosed and claimed herein can be made and executed without undue experimentation in light of the present disclosure. While the compositions and methods of this invention have been described in terms of preferred embodiments, it will be apparent to those of skill in the art that variations may be applied to the compositions and/or methods and in the steps or in the sequence of steps of the method described herein without departing from the concept, spirit and scope of the invention. All such similar substitutes and modifications apparent to those skilled in the art are deemed to be within the spirit, scope and concept of the invention as defined by the appended claims.

What is claimed is:

1. A powder compaction device, comprising:

a drive motor operably connected to a compaction rod, the compaction rod being movable through a loading platform to a cartridge holding platform;

a powder loading station configured to hold a predetermined volume of propellant powder and positioned below the loading platform and above the cartridge holding platform, wherein the compaction rod is movable through the powder loading station and configured to receive the predetermined volume of propellant powder into one or more reliefs defined in the compaction rod as the compaction rod moves through the powder loading station to the cartridge holding platform;

the cartridge holding platform removably holding a cartridge fixture having a hollow interior chamber configured to receive an ammunition cartridge and a funnel defined at an upper portion of the cartridge fixture, the funnel opening into the hollow interior chamber;

wherein the one or more reliefs releases the loaded propellant powder into the funnel to be funneled into the hollow interior chamber after the compaction rod passes through the powder loading station; and

wherein the compaction rod is configured to compact the propellant powder in the hollow interior chamber of the cartridge fixture.

2. The powder compaction device of claim **1**, wherein the powder loading station has a funnel defined at an upper surface of the powder loading station.

3. The powder compaction device of claim **1**, further comprising a remote powder reservoir connected to the powder loading station by a transport conduit.

4. The powder compaction device of claim **3**, wherein the remote powder reservoir further comprises a powder gate positioned between the powder reservoir and the transport conduit, wherein the powder gate controls the flow of powder from the powder reservoir through the transport conduit to the powder loading station.

5. The powder compaction device of claim **4**, further comprising a controller operably connected to the powder gate, the controller being configured to control the amount of powder released from the powder reservoir to be delivered through the transport conduit to the powder loading station by opening and closing the powder gate.

6. The powder compaction device of claim **5**, further comprising one or more sensors in the powder loading station and operably connected to the controller, the one or more sensors being configured to sense a critical volume of propellant powder, which is greater than the predetermined volume of propellant powder, in the powder loading station and to maintain the critical volume of propellant powder by sending a signal to the controller to open the powder gate when a threshold volume is sensed, the threshold volume being less than the predetermined volume of propellant powder.

7. The powder compaction device of claim **1**, further comprising a controller operably connected to the drive motor and configured to control the vertical movement of the compaction rod.

8. The powder compaction device of claim **7**, further comprising one or more sensors on the compaction rod and in communication with the controller, wherein the one or more sensors are configured to sense the vertical distance of movement of the compaction rod and communicate the distance sensed to the controller.

9. The powder compaction device of claim **7**, further comprising one or more sensors on the compaction rod and in communication with the controller, wherein the one or more sensors are configured to control force of the downward pressure exerted by the compaction rod.

10. The powder compaction device of claim **7**, wherein the controller is configured to control the degree of compaction of powder in the ammunition cartridge by controlling the vertical distance the compaction rod moves and the downward force exerted by the compaction rod during movement.

11. The powder compaction device of claim **1**, wherein the cartridge holding platform further comprises a lower groove configured to slidingly receive a corresponding lower tongue on the cartridge fixture.

12. The powder compaction device of claim **1**, wherein the compaction rod further comprises a compaction rod tip.

13. The powder compaction device of claim **12**, wherein the compaction rod tip is removable.

14. The powder compaction device of claim **12**, wherein the shape of the compaction rod tip is selected from a group consisting of: concave, convex, and flat.

15. The powder compaction device of claim **1**, wherein the interior hollow chamber of the cartridge fixture is configured to substantially match the outer dimensions of the ammunition cartridge.

16. The powder compaction device of claim **15**, wherein the interior hollow chamber of the cartridge fixture is configured to receive a standard dimensioned ammunition cartridge selected from a group of ammunition cartridge calibers consisting of .223, .243, .245, .25-06, .270, .277, .300, .308, .338, .30-30, .30-06, .45-70 or .50-90, 50 caliber, 45 caliber, 380 caliber or 38 caliber, 5.56 mm, 6 mm, 6.5 mm, 6.8 mm, 7 mm, 7.62 mm, 8 mm, 9 mm, 10 mm, 12.7 mm, 14.5 mm, 14.7 mm, 20 mm, 25 mm, 30 mm, 40 mm, 57 mm, 60 mm, 75 mm, 76 mm, 81 mm, 90 mm, 100 mm, 105 mm, 106 mm, 115 mm, 120 mm, 122 mm, 125 mm, 130 mm, 152 mm, 155 mm, 165 mm, 175 mm, 203 mm or 460 mm, 4.2 inch and 8 inch ammunition cartridge.

17. The powder compaction device of claim **1**, wherein the compaction rod has a diameter substantially equal to the standard diameter of a projectile aperture in the ammunition cartridge, wherein the ammunition cartridge has standard dimensions for the specific caliber of ammunition.

18. The powder compaction device of claim **1**, wherein the loading platform, the powder loading station and the cartridge holding platform are concentrically aligned about a longitudinal axis of the compaction rod such that the cartridge fixture receives the compaction rod substantially through a center point of the funnel opening into the hollow interior chamber.

19. A powder compaction device, comprising:

a controller in communication with a drive motor operably connected to a compaction rod, the compaction rod being movable through a loading platform to a cartridge holding platform positioned below the loading platform, wherein the controller is configured to control the vertical movement and downward force exerted by the compaction rod;

a powder loading station positioned below the loading platform and above the cartridge holding platform, wherein the controller moves the compaction rod through the powder loading station which holds a predetermined volume of propellant powder, the powder loading station being configured to load the predetermined volume of propellant powder into one or more reliefs defined in the compaction rod as the compaction rod moves through the powder loading station;

the cartridge holding platform removably holding a cartridge fixture having a hollow interior chamber configured to receive an ammunition cartridge, the cartridge

fixture having a funnel defined at an upper portion of the cartridge fixture and opening into the hollow interior chamber;

wherein the propellant powder loaded into the one or more reliefs of the compaction rod is released into the funnel to be funneled into the hollow interior chamber after the compaction rod passes through the powder loading station;

wherein the compaction rod is configured to compact the propellant powder in the hollow interior chamber of the cartridge fixture.

20. The powder compaction device of claim **19**, further comprising a powder reservoir connected to the powder loading station and having a powder gate in communication with the controller, wherein the controller is configured to control the predetermined volume of propellant powder contained within the powder loading station by controlling the opening and closing of the powder gate.

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